

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicants: Toshiharu Furukawa et al. Confirmation No.: 6993  
Art Unit: 1756  
Serial No.: 10/798,908  
Examiner: Stephen D. Rosasco  
Filed: March 11, 2004  
Atty. Docket No.: ROC9200300389US1  
For: METHODS OF FORMING ALTERNATING PHASE SHIFT MASKS  
HAVING IMPROVED PHASE-SHIFT TOLERANCE

Cincinnati, Ohio 45202

Date: January 9, 2007

**DECLARATION UNDER RULE 131**

Commissioner of Patents and Trademarks  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

We, Toshiharu Furukawa, Mark Charles Haakey, Steven John Holmes, David Vaclav Horak, Charles William Koburger, III, Peter H. Mitchell, and Larry Alan Nesbit (the inventors), being duly cautioned and sworn, submit this Declaration in response to the Office Action dated December 20, 2006, and state:

That we are the inventors of the invention entitled "METHODS OF FORMING ALTERNATING PHASE SHIFT MASKS HAVING IMPROVED PHASE-SHIFT TOLERANCE" described and claimed in the application for Letters Patent of the United States, Serial No. 10/798,908, filed March 11, 2004 (the '908 application);

That this is a Declaration under the provisions of Rule 131 and the rules of practice for the United States Patent Office in support of the '908 application;

That the invention described and claimed in the '908 application was conceived prior to November 14, 2003, the publication date of French Publication No. 2839560 and prior to

November 20, 2003, the publication date of International Publication No. WO03/096121, each of these documents in the name of Thony;

That, as evidence of the conception of the invention described and claimed in the '908 application, attached and incorporated into this Declaration as an Exhibit is a copy of a written invention disclosure, which bears a date (now masked), created by one or all of the undersigned inventors in the United States before November 14, 2003 and bearing a date before November 14, 2003 (but with said date now masked);

That the attached Exhibit includes a detailed description of a method of fabricating an alternating phase shift mask and an alternating phase shift mask, which clearly demonstrates that such method of fabricating the alternating phase shift mask and the alternating phase shift mask embody the elements claimed in at least pending independent claim 1 and 27 of the '908 application, and which were conceived before the November 14, 2003 publication date of Thony;

That the conception of the inventions claimed in at least pending independent claims 1 and 27 of the '908 application is fully supported by the attached Exhibit, and that all drawings and text included in the Exhibit having been created in the United States by one or all of the undersigned inventors before the November 14, 2003 publication date of Thony;

That the Exhibit demonstrates as follows:

That a method of fabricating an alternating phase shift mask was conceived before November 14, 2003;

That the method of fabricating an alternating phase shift mask comprised forming a layer of a phase shift mask material on a handle substrate; patterning the layer to form a plurality of phase shift windows in the phase shift mask material; and transferring the patterned layer from the handle substrate to a mask blank to construct the alternating phase shift mask, as called for in pending independent claim 1 in the '908 application;

That an alternating phase shift mask was conceived before November 14, 2003;

That the alternating phase shift mask was produced by the process comprising forming a layer of a phase shift mask material on a handle substrate; patterning the layer to form a plurality of phase shift windows in the phase shift mask material; and transferring the patterned

layer from the handle substrate to a mask blank to construct the alternating phase shift mask, as called for in pending independent claim 27 in the '908 application;

That the undersigned inventors were diligent from before November 14, 2003, which represents the publication date of U.S. Patent Application Publication No. 2004/0217391, to March 11, 2004, which represents the filing date of the '908 application. Specifically, the undersigned inventors can account for the entire period during which reasonable diligence is required with affirmative acts within the United States and acceptable excuses. During this period, the attorneys acted within the United States with reasonable diligence on the application. Specifically, in-house counsel for the Assignee was reasonably diligent in considering the attached Exhibit prepared by the inventors and subsequently forwarding the attached Exhibit to outside counsel for the Assignee on November 11, 2003 with instructions to prepare a patent application on the subject matter of the Exhibit. Subsequently, outside counsel for the Assignee was reasonably diligent in preparing a working draft of specification the '908 application and forwarding the working draft of the specification to the inventors for their review on February 17, 2004. In particular, outside counsel for the Assignee had a reasonable backlog of unrelated cases taken up in chronological order and carried out expeditiously. The inventors were reasonably diligent in reviewing and approving the working draft of the specification between February 17, 2004 and February 24, 2004. Outside counsel for the Assignee was reasonably diligent in finalizing the specification of the '908 application, after receiving comments from the inventors' review, and forwarding the finalized specification to in-house counsel for the Assignee on February 24, 2004. In-house counsel for the Assignee was reasonably diligent in forwarding the specification for the '908 application and a Declaration/Power of Attorney to the inventors, who executed the Declaration/Power of Attorney on March 3, 2004 and March 10, 2004. In-house counsel for the Assignee was reasonably diligent in filing the '908 application and the executed Declaration/Power of Attorney at the U.S. Patent and Trademark Office on March 11, 2004;

Therefore, in summary, the Declaration and attached Exhibit constitute a showing of facts, in character and weight, that establish conception of the invention prior to the publication date of French Publication No. 2839560 and prior to the publication date of International Publication No. WO03/096121 for a method of fabricating an alternating phase shift mask and an

alternating phase shift mask that are the subjects of and are claimed in Application Serial No. 10/798,908, all the acts of which occurred in the United States BEFORE November 14, 2003, and thus precede the publication date of French Publication No. 2839560 and the publication date of International Publication No. WO03/096121, and that the inventors and counsel for the inventors exhibited diligence from prior to the publication date of November 14, 2003 for French Publication No. 2839560 and from prior to the publication date of November 20, 2003 for International Publication No. WO03/096121, each in the name of Thony, to the filing date of the '908 application;

We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Further declarants sayeth naught.

By \_\_\_\_\_  
Toshiharu Furukawa

Date \_\_\_\_\_

By \_\_\_\_\_  
Mark Charles Hakey

Date \_\_\_\_\_

By \_\_\_\_\_  
Steven John Holmes

Date \_\_\_\_\_

By \_\_\_\_\_  
David Vaclav Horak

Date \_\_\_\_\_

By \_\_\_\_\_  
Charles William Koburger, III

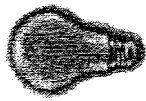
Date \_\_\_\_\_

By \_\_\_\_\_  
Peter H. Mitchell

Date \_\_\_\_\_

By Larry Alan Nesbit  
Larry Alan Nesbit

Date January 10, 2007



## Disclose ROC8-2003-0558

Prepared for and/or by an IBM Attorney -

Created By Charles Koburger III On 04/24/2003 01:29:00 PM EDT

Last Modified By Deb Peterson On 11/04/2003 01:31:34 PM MST

Required fields are marked with the asterisk (\*) and must be filled in to complete the form.

### \*Title of disclosure (in English)

Alternating Phase Shift Photomask With Improved Phase-shift Tolerance

### Summary

Status	Under Evaluation
Final Deadline	
Final Deadline Reason	
*Processing Location	Rochester
*Functional Area	select (1F) 1F - ETS - Engineering & Technology Services (Non-Rochester Inventors)
Attorney/Patent Professional	James R Nock/Rochester/IBM
IDT Team	select James R Nock/Rochester/IBM Tom Faure/Burlington/IBM
Submitted Date	07/16/2003 01:16:21 PM EDT
*Owning Division	select ETS
Incentive Program	
Lab	
*Technology Code	101J3
PVT Score	

### Inventors with a Blue Pages entry

Inventors: Charles Koburger III/Fishkill/IBM, Mark Hakey/Burlington/IBM, Peter Mitchell/Burlington/IBM, Steven Holmes/Burlington/IBM, Larry Nesbit/Fishkill/IBM, Dave Horak/Burlington/IBM, Toshiharu Furukawa/Burlington/IBM@IBMUS

Inventor Name	Inventor Serial	Div/Dept	Inventor Phone	Manager Name
> Koburger III, Charles W.	718628	21/LMJA	446-4642	Hakey, Mark C.

Hakey, Mark C.	638733	21/IQ2A	446-9529	Ravey, Timothy (Tim)
Mitchell, Peter H.	966143	21/LMJA	446-3214	Hakey, Mark C.
Holmes, Steven J.	048065	29/OH/A	532-2026	Bukofsky, Scott J.
Nesbit, Larry A.	784655	29/G3eG	446-0194	Chapman, Phillip F.
Horak, David V.	639061	29/BIXA	446-9875	Sekiguchi, Akihisa (Ak)
Furukawa, Toshiharu	219417	21/LMJA	446-8354	Hakey, Mark C.

> denotes primary contact

## Inventors without a Blue Pages entry

### IDT Selection

Attorney/Patent Professional James R Nock/Rochester/IBM  
 IDT Team James R Nock/Rochester/IBM  
 Tom Faure/Burlington/IBM  
 Response Due to IP&L 08/24/2003

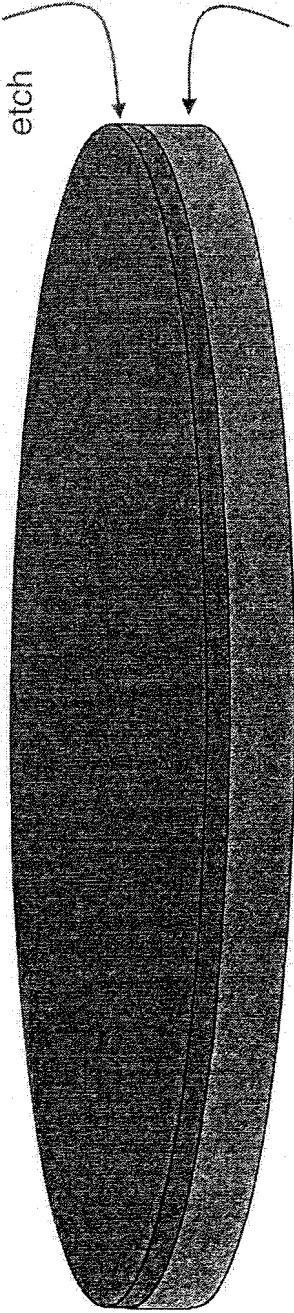
### \*Main Idea

1. Background: What is the problem solved by your invention? Describe known solutions to this problem (if any). What are the drawbacks of such known solutions, or why is an additional solution required? Cite any relevant technical documents or references.  
 As optical lithography is extended to images substantially smaller than the exposure wavelength, we need to use resolution enhancement techniques such as alternating phase shift. The fabrication of alternating phase shift masks is limited by the uniformity capabilities of the etch processes that define the phase shift regions. The etch processes do not have an etch stop layer, so the inherent pattern factor and across substrate variations in the RIE chamber are replicated in the substrate. This variation in etch depth causes small focus window and effectively reduced resolution.

2. Summary of Invention: Briefly describe the core idea of your invention (saving the details for questions #3 below). Describe the advantage(s) of using your invention instead of the known solutions described above.  
 We propose that much-improved control of phase-shift tolerances can be achieved by taking advantage of well-know tightly-controlled techniques for deposition of oxide/quartz films using CVD or thermal oxidation of silicon wafers. These films with well-controlled thickness can then be bonded to a mask blank having appropriate optical characteristics (same index of refraction) to achieve phase shifting films with improved depth/thickness control.

3. Description: Describe how your invention works, and how it could be implemented, using text, diagrams and flow charts as appropriate.

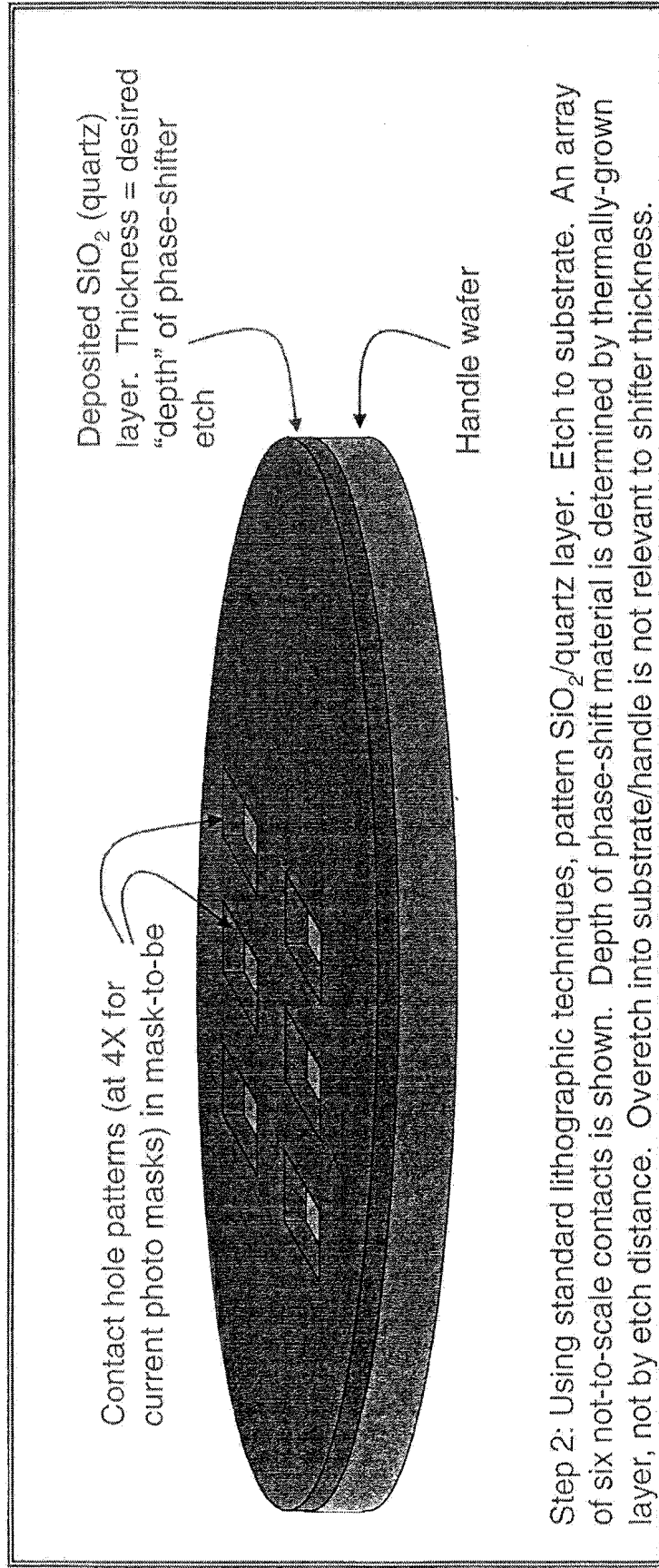
**Deposited SiO<sub>2</sub> (quartz)  
layer. Thickness = desired  
"depth" of phase-shifter  
etch**



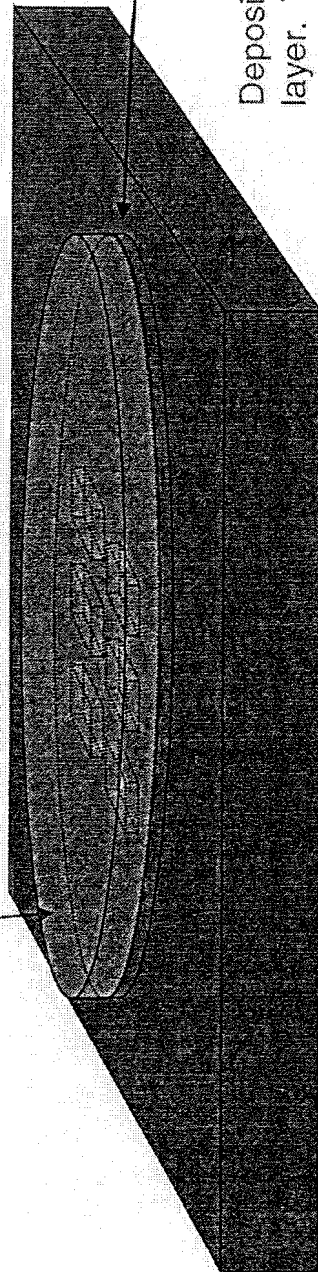
**Handle wafer**

Step 1: Deposit (or grow) quartz/SiO<sub>2</sub> layer on substrate. Substrate can be a silicon wafer. Other appropriately-flat handle materials may be substituted for silicon if they meet required high temperature requirements. Uniformity of CVD (or thermal oxidation) process provides improved control of final phase-shifter thickness tolerance, with no RIE-lag effects.





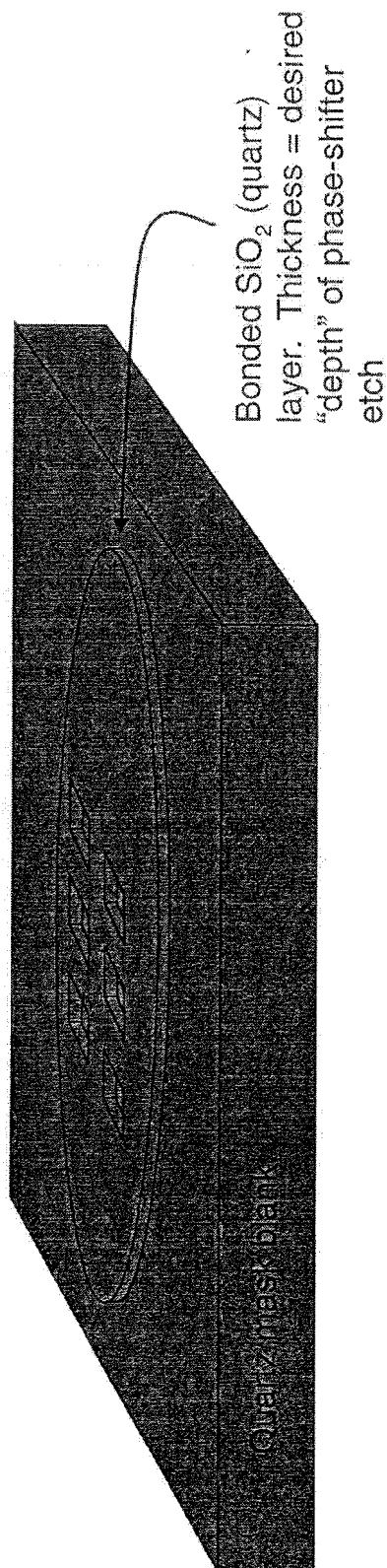
Handle wafer



Deposited  $\text{SiO}_2$  (quartz)  
layer. Thickness = desired  
"depth" of phase-shifter

Step 3: Bond surface of patterned  $\text{SiO}_2$ /quartz layer to standard mask blank using SOI-like bonding method(s).

(Note that handle/patterned layer could be cleaved/diced to final (4X) dimension prior to bonding if required.)



Step 4) Etch away handle material. Voilà.  
Dissimilar materials mean removing handle will not substantially affect phase shifter layer.